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AUTHOR Bishart, Gus; Werner, Claire
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ABSTRACT

Competencies for production machine shop are provided for the first of four topic areas: principles and practice of machine shop. Each competency appears in a one-page format. It is presented as a goal statement followed by one or more "indicator" statements, which are performance objectives describing an ability that, upon attainment, will establish competency for the stated goal. Indicator statements are further qualified by one or more "benchmark" statements or observable behaviors describing what the trainee will do to prove that he/she is demonstrating achievement of the performance objective. Benchmark statements are followed by an "assessment" statement, which describes how the observer determines that the benchmark is achieved and establishes the criteria for performance. The competencies for this topic are divided into 11 sections: machine shop occupations; safety; project design; machine tools; reading drawings and sketching objects; metric system of measurement; rules, gauges, calipers; metals; principles of measurement and inspection; hand tools and benchwork; and planning projects. (YLB)

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Production Machine Shop Employment Competencies Part One: Practices and Principles

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PREFACE

The competencies for Production Machine Shop have been developed in four topic areas as follows:

1) Part One: Principles and Practice of Machine Shop
2) Part Two: Saws, Drills, and Grinders
3) Part Three: The Engine Lathe
4) Part Four: The Milling Machine

Each topic has a number of competencies identified. The competencies are presented as a series of goal statements followed by one or more "indicator" statements. An "indicator" is a performance objective describing an ability, which, upon attainment, will establish competency for the stated goal.

Indicator statements are further qualified by a series of "benchmark" statements. A "benchmark" is an observable behavior. Benchmarks describe what the trainee will do to prove that he is demonstrating achievement of the performance objective. Benchmarks are an end result, they do not describe how the trainee learned the behavior, they only state what the behavior is. There may be one or more benchmarks (behaviors) for each indicator statement (performance objective). Benchmark statements are followed by an "assessment" statement. The assessment statement describes how the observer determines that the benchmark is achieved. Assessment statements establish the criteria for performance. Instructor, class member consensus opinion, or combination of instructor input and trainee input may contribute to the final determination of evaluation criteria. The assessments that are chosen provide the basis for performance evaluation for each benchmark.

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USE OF THE COMPETENCIES

The integration of the material into course curriculum is dependent on the agency providing JTPA training services. Selection of competencies should be based on participant need and compatibility with the course of instruction. The identification of Production Machine Shop Competencies does not attempt to provide input in regards to teaching methodology. The statements present a consensus opinion of optimum skill level for youth entering the work force in the area of Production Machine Shop.

VALIDATION

The competencies were developed from research and direct experience in the instruction of JTPA participants. Validation of the attached material was achieved through a consensus of instructional staff and employer Advisory Boards. Their collective opinion was formed from research and data, which provided the basis for the selection of Production Machine Shop Competencies.

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ACKNOWLEDGEMENTS

Appreciation is extended to the Los Angeles Unified School District's Skills Center Coordinators, counselors and instructional staff who have provided their time and cooperation during the research and data collection stages of this project.

Grateful acknowledgement is made of Lucinda Stites, Word Processing Instructor, and her crew of student word processors who have assisted during the production of materials.

The technical information provided in the attached material has been developed form the course text, General Industrial Machine Shop by Harold V. Johnson, Chas. A. Bennett Co., Inc., Peoria, Ill.

Competencies have been written by Gus Bishart with the assistance of Claire Werner as part of the school district's contract with the City of Los Angeles and the State of California.

Bernardo P. Sandoval, Director
Manpower Program Development
December, 1984

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SECTION ONE

MACHINE SHOP OCCUPATIONS

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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies Machine Shop occupations.

BENCHMARK: The trainee identifies five out of seven machining occupations.

ASSESSMENT: The trainee names the following occupations:

1. All-Around Machinist
2. Tool and Die Makers
3. Experimental Machinist
4. Setup Workers (Machine Tools)
5. Machine Tool Operators
6. Layout Workers
7. Instrument Makers

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SECTION TWO

SAFETY

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists twelve general safety rules used in a Machine Shop.

ASSESSMENT: The trainee lists the following general safety rules:

1. Avoid wearing clothing that might catch in moving or rotating parts.
2. Remove all burrs from workpieces to avoid cuts.
3. Always wear safety glasses while in the shop.
4. Keep away from moving belts.
6. Be sure all guards are in place.
7. Protect against inhaling harmful fumes.
8. Protect against inhaling dust of any kind, especially from grinding wheels.
9. Learn the correct method to lift heavy workpieces to the machine.
10. Gloves must be worn when handling sheet metal or large pieces of stock.
11. Be careful of other workers when carrying long pieces of bar stock.
12. Long hair is a hazard in the shop. It must be pulled back.

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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists six safety rules for safety precautions when doing bench work.

ASSESSMENT: The trainee lists the following safety precautions:

1. Use tools correctly.
2. Do not carry sharp-edged or pointed tools in your pockets.
3. Never use a file without a handle.
4. Do not use a file as a hammer.
5. Always check the fit of the handle in the hammer head.
6. Be sure a wrench fits the nut snugly.

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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists two safety precautions while handling tool materials.

ASSESSMENT: The trainee lists the following safety precautions:

1. When no chip breaker is ground into a tool for turning metal, the turnings come off the workpiece in long, hot bands. These bands wind around the workpiece or the controls of the machine. Such ribbons are dangerous. Prevent this by using a well-designed chip breaker.

2. Wear safety glasses or goggles at all times.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists five safety precautions for lathe work.

ASSESSMENT: The trainee identifies the following safety precautions:

1. Keep hands and clothing away from rotating parts such as the workpiece, exposed gears, and the lathe dog.
2. Proper guards must always be in place.
3. Do not wear clothing that will create a hazard. Keep cotton waste and rags clear of the machine. Do not wear rings or wrist watches.
4. Stop the lathe before making any adjustments on the toolholder.
5. Never leave the chuck key in the chuck.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists eight safety precautions for the milling machine.

ASSESSMENT: The trainee identifies the following safety precautions:

1. Do not remove chips from the milling machine table by hand. Use a brush for that purpose.
2. When clamping the workpiece to the table, use only wrenches that properly fit the nut or bolt heads.
3. Keep the table free from all tools or materials.
4. Wear safety glasses to protect the eyes from flying chips.
5. Clean the arbor and spindle hole before inserting the arbor or adapters in the spindle.
6. Sprung arbors should not be used. Obtain a straight arbor before the cutters and spacing collars are put in place.
7. Never oil or clean the machine while it is in motion.
8. Never leave the machine while it is in operation.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists eight safety precautions for the drill press.

ASSESSMENT: The trainee identifies the following safety precautions:

1. Keep extra drills, cutting oil cans, brushes, and materials where they will not interfere with your work.
2. Don't reach in back of a moving drill press.
3. Never drill the workpiece without using a drill vise or otherwise clamping the work securely.
4. Don't use fingers, a wad of waste, or an air hose to remove chips from table and workpiece.
5. Wear clothing that fits well and comfortably, with sleeves rolled up to the elbow. Don't wear a necktie, long sleeves, gloves, rings, bracelets, or anything that might get caught in the drill.
6. Remove chuck key and drift from the machine before starting the drill.
7. See that the drills, chucks, and holding devices are in good condition.
8. Don't use a drill ground for work in steel when drilling brass or copper.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies safety procedures typically used in Machine Shop.

BENCHMARK: The trainee lists nine safety precautions for grinding machines.

ASSESSMENT: The trainee identifies the following safety precautions.

1. On odd-hand grinders, make sure that protective guards are in place. Make sure the tool rest is correctly adjusted.
2. Stand to one side of grinding wheel when first starting the machine.
3. It is imperative that safety glasses are worn when working on a grinding machine. Wear safety glasses at all times.
4. Dress properly before working on a grinding machine. Roll up sleeves, remove scarves, neckties, and all jewelry.
5. The workpiece must not be forced against a cold wheel.
6. Do not use a grinding wheel that is assembled to the shaft with flanges of two different types or sizes. Traveling at a terrific speed, such a wheel will explode.
7. Wheels worn out-of-round should be trued.
8. Wheels used for wet grinding should not be permitted to stand partly immersed in water.
9. Follow the recommended speeds for wheels given by the manufacturer.

SECTION THREE

PROJECT DESIGN

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates an understanding of project design.

BENCHMARK: The trainee identifies the elements of design.

ASSESSMENT: The trainee lists the following design elements:

1. Line (straight, circular, and curved)
2. Shape (round, square, triangular, and rectangular)
3. Mass (the three-dimensional aspect of an object)
4. Texture (the surface character of a material)
5. Color (the natural color of a metal)

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates an understanding of project design.

BENCHMARK: The trainee identifies and defines the principles of design.

ASSESSMENT: The trainee lists the following principles of design:

1. Balance - An object is said to have balance when its corresponding parts seem equal in weight or appearance. There are two types of balance, FORMAL (or symmetrical) and INFORMAL (asymmetrical).

2. Unity - When the parts combine to make one whit.

3. Proportion - The relationship between the dimensions of an object.

4. Harmony - The shapes, colors, and textures of an object that look well together.

5. Rhythm - The repetition of shapes, colors, or lines at regular intervals.

6. Emphasis - The focus of attention on a certain part of an object.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates an understanding of project design.

BENCHMARK: The trainee identifies points to consider when planning a project design.

ASSESSMENT: The trainee lists the following points:

1. Is the design practical?
2. Is the design appropriate for the project?
3. Is the project designed to fit in well with its surroundings?
4. Can the design be carried out safely and easily with the tools and equipment on hand?
5. Are the materials need for the design available and cost effective?

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates an understanding of project design.

BENCHMARK: The trainee identifies steps to take when developing a project design.

ASSESSMENT: The trainee identifies the following steps:

1. Consider what is the best way to use my abilities, equipment on hand, and available materials, to make the project attractive and functional.
2. Make several freehand sketches of the idea.
3. Discuss the project with the teacher. Make improvements where needed.
4. Make a bill of materials and a plan of procedure.

SECTION FOUR

MACHINE TOOLS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies the fundamental principles of modern machine tools.

BENCHMARK: The trainee identifies and describes simple machines.

ASSESSMENT: The trainee provides the following information:

1. Lever - A lever is a rigid bar that is free to turn about a fixed point called a fulcrum.
2. Pulley - A pulley is a wheel that turns readily on an axle.
3. Wheel-and-Axle - A wheel-and-axle is a wheel or crank rigidly attached to an axle.
4. Inclined Plane - Is used to elevate an object without lifting it vertically.
5. Wedge - A wedge is a double inclined plane.
6. Screw - A screw is an inclined plane wound about a cylinder.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies the fundamental principles of modern machine tools.

BENCHMARK: The trainee defines the primary functions of machine tools. The trainee identifies the six classes of machine tools.

ASSESSMENT: The trainee provides the following information:

1. The function of all machine tools is to produce metal parts by changing the shape, size, or finish of a piece of material. The shape of a part made with a machine tool is limited by the types of motion the tool can apply.

2. Standard machine tools are grouped in six basic classes:
   a. LATHES
   b. DRILLING MACHINES
   c. SHAPERS
   d. PLANERS
   e. MILLING MACHINES
   f. GRINDING MACHINES

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee identifies the fundamental principles of modern machine tools.

BENCHMARK: The trainee identifies the basic function of selected machine tools.

ASSESSMENT: The trainee provides the following information:

1. Lathes - The engine lathe is a machine tool that produces a cutting action by rotating the workpiece against the cutting edge of the tool.

2. Drilling Machines - The drilling machine is a machine tool that produces the necessary cutting action by the rotation of a multiple-edged cutting tool.

3. Shaping and Planing Machines - Both of these machines can machine flat surfaces with a single point tool. Straight-line, or reciprocating, motion is applied to both the workpiece and tool in these machines.

4. Milling Machines - A milling machine provides cutting action to a rotating tool.

5. Grinding Machines - A grinder differ from other machines in that it uses a tool made of emery, carborundum, or similar materials. The wheel, made up of many tiny cutting points, cuts with the entire surface area that comes in contact with the material being ground. Grinders cut with a grinding action, removing material in the form of tiny particles.

SECTION FIVE

READING DRAWINGS AND SKETCHING OBJECTS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee identifies the primary information a machine shop drawing will provide.

ASSESSMENT: The trainee states that machine shop drawings should tell what material to use, the size and shape of each part, and what the finished object will look like.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee describes the types of drawings most commonly used in machine shop.

ASSESSMENT: The trainee provides the following information:

1. Working Drawing (Orthographic projection)

   This drawing may have one or several views. Usually required are the front, top, and side or end views.

2. Assembly Drawing

   The assembly drawing shows how the parts fit together.

3. Detail Drawing

   The detail drawing gives complete dimensions and notes for making the parts.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee identifies the types of lines used in machine shop drawings and describes their meaning.

ASSESSMENT: The trainee provides the following information:

1. Object Lines - are used to show the shape or outline of the part to be made. The object line is heavier than a dimension or center line.

2. Section Lines - are thin and equally spaced. Various symbols for these lines are also used to indicate different kinds of materials and to save work.

3. Hidden Lines - are used when parts of an object are concealed by front surfaces.

4. Center Lines - represents the axis of a symmetrical part, such as a circle or an arc. They are light broken lines consisting of alternately long and short dashes, closely and evenly spaced.

5. Dimension Lines - are unbroken except at the dimension. They have an arrowhead at each end to indicate the limit of the object.

6. Extension Line - extends the edge of the object that is to be dimensioned.

7. Cutting Plane Lines - are heavy, long and short dashes (one long, two short, one long, two short, etc.) alternately and evenly spaced. They are used to show a section that is to be removed.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

8. Break Lines - indicate the continuation of the object, which cannot be included in the drawing because of space limitations.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee describes how dimensions are shown on a drawing.

ASSESSMENT: The trainee states dimensions are shown entirely with whole numbers, or entirely with decimals, or with a combination of the two.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee defines "tolerance" as it is used in a machine shop drawing which shows dimensions.

ASSESSMENT: The trainee states "tolerance" is the amount of variation permitted in the size of a part or in the location of points or surfaces.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee identifies sectional view drawings.

ASSESSMENT: Given a machine shop blueprint, the trainee identifies the sectional views.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee computes the actual size of an object from a scale drawing.

ASSESSMENT: Given a scale drawing the trainee interprets the ratio to determine the actual size of the object.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee explains the meaning of the symbol "V" on a machine shop drawing.

ASSESSMENT: The trainee states that finished or machined surfaces are indicated by a "V" like mark.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee identifies symbols for screw threads and finish marks.

ASSESSMENT: Given a machine shop drawing the trainee identifies where the symbols for screw threads and finish marks are shown.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee distinguishes between general notes and local notes on a machine shop drawing.

ASSESSMENT: The trainee states that:

1. General notes apply to an entire drawing.
2. Local notes apply to specific items on a drawing.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee identifies "notes" on a machine shop drawing.

ASSESSMENT: Given a machine shop drawing the trainee identifies notes and explains their meaning. The trainee points to notes which show holes that are to be drilled, bored, reamed, punched, or cored.

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COMPETENCY AREA:	PRODUCTION MACHINE SHOP
COMPETENCY STATEMENT:	The trainee understands typical Machine Shop practices.
INDICATOR:	The trainee demonstrates the ability to read drawings and to sketch objects.
BENCHMARK:	The trainee identifies types of information given in notes shown on a machine shop drawing.
ASSESSMENT:	The trainee states that notes include specification information such as special instructions for machining, kind of material, heat treatment, and finish.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee provides the meaning for common machine shop abbreviations used on drawings.

ASSESSMENT: The trainee provides the following information:

Abbreviations	Meaning
THD.	Thread
NC	National Coarse
NF	National Fine
UNC	Unified N. C.
UNF	Unified N. F.
DIA.	Diameter
R	Radius
RH	Right Hand
LH	Left Hand
FAO	Finish All Over
CSK	Countersink
CBORE	Counterbore
CI	Cast Iron
CRS	Cold-rolled Steel
HDN.	Harden
RPM	Revolutions per Minute
ASSY.	Assembly
CP	Circular Pitch
DR.	Drill
GA.	Gage or Gauge

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates the ability to read drawings and to sketch objects.

BENCHMARK: The trainee sketches machine shop objects.

ASSESSMENT: The trainee completes no less than two sketches of objects produced on a machine tool. Instructor's approval indicates satisfactory completion.

SECTION SIX

METRIC SYSTEM OF MEASUREMENT

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the metric system of measurement.

BENCHMARK: The trainee uses a conversion chart to translate customary units of measure to metric measurements typically used in Machine Shop.

ASSESSMENT: Given a set of problems requiring the conversion of customary units of measure into metric measurements, the trainee utilized the following chart correctly.

	When you know:	You can Find:	If you multiply by:
Length	inches	millimetres	25
	feet	centimetres	30
	yards	metres	0.9
	miles	kilometres	1.6
	millimetres	inches	0.04
	centimetres	inches	0.4
	metres	yards	1.1
	kilometres	miles	0.6
Area	square inches	square centimetres	6.5
	square feet	square metres	0.09
	square yards	square metres	0.8
	square miles	square kilometres	2.6
	acres	square hectometres (hectares)	0.4
	square centimetres	square inches	0.16
	square metres	square yards	1.2
	square kilometres	square miles	0.4
	square hectometres (hectares)	acres	2.5
Mass	ounces	grams	28
	pounds	kilograms	0.45
	short tons	megagrams (metric tons)	0.9
	grams	ounces	0.035
	kilograms	pounds	2.2
	megagrams (metric tons)	short tons	1.1
Liquid Volume	ounces	grams	30
	pints	litres	0.47
	quarts	litres	0.95
	gallons	litres	3.8
	millilitres	ounces	0.034
	litres	pints	2.1
	litres	quarts	1.06
	litres	gallons	0.26
Temperature	degrees Fahrenheit	degrees Celsius	5/9 (after sub. 32)
	degrees Celsius	degrees Fahrenheit	9/5 (then add 32)

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the metric system of measurement.

BENCHMARK: The trainee identifies the seven base units of the International System of Units (SI).

ASSESSMENT: The trainee completes a chart which identifies the seven base units of the SI system of measure.

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampre	A
Temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the metric system of measurement.

BENCHMARK: The trainee identifies the two types of dual dimensioning shown on blueprints.

ASSESSMENT: Given a blueprint the trainee points to and defines the meaning of two types of dual dimensions as follows:

1. The millimetre dimension is placed above the inch dimension. The decimal equivalent is always used to show inch dimensions.

2. A readout table is shown on the drawing showing the metric dimension corresponding to the inch measurement.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the metric system of measurement.

BENCHMARK: The trainee names the types of metric conversion units used on machine tools.

ASSESSMENT: The trainee states the following:

1. "Paste-on" conversion scale located in some convenient place on the machine.
2. Drum model conversion unit.
3. Mechanical dual-reading scales.
4. Machines with dual-reading capabilities.

SECTION SEVEN

RULES, GAGES, CALIPERS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee identifies and describes the use of metric rules, hook rules, and circumference rules.

ASSESSMENT: The trainee provides the following information:

1. Metric Rules - A rule marked with numbered lines in millimetres.

2. Hook Rule - A rule used for taking measurements through holes in gears or pulleys.

3. Circumference Rules - A circumference rule is used for sheet metal layout. On one edge is a regular rule for measuring diameters. On the opposite edge a scale shows the corresponding circumferences.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee demonstrates the correct use of metric rules and hook rules.

ASSESSMENT: Given a list of measurements to take, the trainee selects the correct rule, measures the item, and writes down an accurate measurement.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee describes the use of a caliper.

ASSESSMENT: The trainee states:

The caliper is used for outside and inside calipering. Measurement, both inside and outside, read to a line rather than to a face of a jaw. The outside and inside reading lines are marked "out" and "in". The caliper rule can be locked, setting the slide at any point. The caliper is made in 3", 5", and 6" sizes.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee demonstrates the use of calipers.

ASSESSMENT: Given a set of objects to measure, the trainee selects the correct calipers (outside caliper, inside caliper, or hermaphrodite caliper) and takes an accurate measurement.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee identifies various gages and relates their function.

ASSESSMENT: Given a set of measurement tools the trainee identifies the following gages:

Surface Gage -
1. Locates distances from a base and locates points at a given height on the opposite ends of an object lying on a flat surface.
2. May be used to draw a line at a given height on an irregularly shaped object.
3. May be used to level castings on a machine.
4. With an indicator attached, the gage can be used for inspection work and checking machine spindles.

Combined Protractor and Depth Gage - Is used for setting bevels, transferring angles, and gaging depths.

Depth Gage - All bases have gaging positions at center and at the end. This makes them suitable for taking difficult measurements.

Telescoping Gage - Used for measuring internal diameters.

Planer or Shaper Gage -
1. Setting the cutting tool on a shaper or planer.
2. Using with gage blocks in building up work on a surface plate.
3. Using with a sine bar in grinding angles.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

4. Using with an indicator for transferring measurements.

5. Using as an adjustable parallel.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee identifies and describes a combination depth and angle gage.

ASSESSMENT: The trainee provides the following information:

Combination depth and angle gage is used to measure the depth of holes and slots. It consists of a steel head, designed to fit the hand. The rule is 3/16" in width. One side is marked in thirty-seconds of an inch. The other side is marked in sixty-fourths of an inch. All blades are tempered and fitted in the slot of the head. They can be securely clamped at any point by a knurled nut and tension spring. The rule is removable for use separately in measuring.

Given a set of measurement tools, the trainee identifies a combination depth and angle gage.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee describes the narrow steel rule.

ASSESSMENT: The trainee provides the following information:

The narrow steel rule is used for measuring the depths of slots or small, deep holes. It is about 1/25" think and 3/16" wide. It is graduated on one edge of each side.

Given a set of measurement tools, the trainee identifies the narrow steel rule.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee describes the combination set and demonstrates its use.

ASSESSMENT: The trainee provides the following information:

The combination set consists of three separate tools and a steel rule that may be use with each. It consists of a graduated, hardened steel blade with a sliding try-square head that also combines a mitre and level. It can be used as a rule, square, mitre (for angles), depth gage, height gage, and level. The protractor head has direct-reading double graduations with a full 0° to 180° in opposite directions. This allows for direct reading of angles eight above or below the blade. Along the center of the rule is a groove. This serves as a guide for clamping the head in a fixed position.

Given objects to measure, the trainee uses the combination set correctly, and records accurate measurements.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee identifies squares and describes the various uses of squares.

ASSESSMENT: The trainee provides the following information:

A square has one right angle and two straight edges for measuring and marking. Given a set of measurement tools the trainee identifies a square.

Squares are used for:

1. Layout work.
2. Testing the accuracy of two surfaces that must be square or at right angles to each other.
3. Laying out lines that must be parallel to each other.
4. Setting up workpieces in the shaper or milling machine.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee describes the function and use of a divider.

ASSESSMENT: Given a set of measurement tools, the trainee identifies a divider.

The trainee relates the function of a divider as used like a compass to lay out regular curves. They are used mostly to indicate the location and size of holes to be drilled.

The trainee demonstrates the correct use of a divider.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee describes the function and use of a trammel.

ASSESSMENT: Given a set of measurement tools, the trainee identifies a trammel.

The trainee states that a trammel is a layout tool used to measure between two points. It can be used to scribe circles or arcs too large for ordinary dividers.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of common rules, gages, and calipers typically used in Machine Shop.

BENCHMARK: The trainee identifies parallels, V-blocks, and toolmaker's parallel clamps.

ASSESSMENT: Given a set of measurement tools the trainee identifies the following parallels, V-blocks, and toolmaker's parallel clamp:

1. Nonadjustable parallel - Used with the milling machine and shaper vises for setting up the workpiece.

2. Adjustable parallel - Able to change width of th parallel.

3. V-Block - Used to hold round work for layout work and drilling, milling, grinding, and other machining operations.

4. Toolmaker's Parallel Clamp - Used for holding small work together in drilling and tapping.

SECTION EIGHT

METALS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee demonstrates an understanding of the classification of metals.

BENCHMARK: The trainee defines the meaning of metal alloy and provides names for common alloys.

ASSESSMENT: The trainee provides the following information:

1. The term alloy is used to identify any metallic system. It is a substance with metallic properties composed of two or more elements, intimately mixed. Of these elements one must be a metal.

2. Alloys may be further classified as "ferrous" and "nonferrous." Ferrous alloys contain iron. Nonferrous alloys do not contain iron.

3. Common alloys include copper-based, brass, bronze, zinc-based, nickel-based, and tin-based.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee identifies fundamental properties of metals.

BENCHMARK: The trainee identifies the three categories of metal.

ASSESSMENT: The trainee states the properties of metal are classified as (1) chemical properties, (2) mechanical properties, and (3) physical properties.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee identifies fundamental properties of metal.

BENCHMARK: The trainee names the mechanical properties of metals.

ASSESSMENT: The trainee provides the following information:

1. Hardness
2. Brittleness
3. Plasticity and Ductility
4. Toughness
5. Malleability
6. Strength
7. Elongation
8. Yield Point
9. Stress
10. Fatigue
11. Fusibility
12. Strain

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee demonstrates an understanding of iron commonly used in machine shop.

BENCHMARK: The trainee names various types of iron.

ASSESSMENT: The trainee provides three out of nine of the following:

1. Gray Cast Iron
2. Pearlite Gray Iron
3. White Cast Iron
4. Chilled Cast Iron
5. Malleable Cast Iron
6. Black-Heart Malleable Iron
7. White-Hear Malleable Iron
8. Nodular or Ductile Cast Iron
9. Wrought Iron

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee is able to distinguish between plain carbon and alloy steels.

BENCHMARK: The trainee defines the term "plain carbon steel".

ASSESSMENT: The trainee states that "carbon steel" is used to distinguish a steel to which no alloying elements have been added in appreciable amounts.

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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee is able to distinguish between plain carbon and alloy steels.

BENCHMARK: The trainee names and describes the three classifications of plain carbon steels.

ASSESSMENT: The trainee states the three classes of plain carbon steels are:

1. Low-Carbon Steel

   Known as "soft" or mild steel. It is used where ductility and softness are important and a high tensile strength is not required. Low carbon steels are used for operations as spinning, cold bending, riveting, and swagging. Products such as screws, nails, nuts, bolts, washers, wire fence, machine parts and forged parts can be made from this type of steel.

2. Medium-Carbon Steel

   Are less ductile, harder, and have a greater tensile strength than the low-carbon steels. These steels are very responsive to heat treatment. These steels are used for shafts, connecting rods, spindles, gears, and other machine parts requiring medium-strength and wear-resisting surfaces.

3. High-Carbon Steel

   Have a higher tensile strength and hardness than those in the lower carbon range. They respond readily to heat treatment. High-carbon steel is used for cutting tools, especially with alloys.

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COMPETENCY AREA:	PRODUCTION MACHINE SHOP
COMPETENCY STATEMENT:	The trainee is aware of the various materials used in a production machine shop.
INDICATOR:	The trainee is able to distinguish between plain carbon and alloy steels.
BENCHMARK:	The trainee defines in general terms the meaning of alloy steel.
ASSESSMENT:	The trainee states, steel is considered an alloy steel when the maximum of range given for the content of alloying elements exceeds one or more of a pre-determined set of limits as determined by the American Iron and Steel Institute.

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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of the various materials used in a production machine shop.

INDICATOR: The trainee is able to distinguish between plain carbon and alloy steels.

BENCHMARK: The trainee identifies the three classifications of alloy steels.

ASSESSMENT: The trainee provides the following information:

1. Constructional Alloy Steel

   Are used in machine parts such as levers, shafts, gears,bolts, pistons, springs, and connecting rods.

2. Alloy Tool Steel

   Any steel that is used for the working parts of tools. Alloy tool steels are used in the manufacture of cutting and forming tools, taps, dies, reamers, drills, milling cutters, punches, and similiar items.

3. Special Alloy Steels

   Are designed for specific purposes when high heat or corrosion-resistant steel is required. Also are the steels used on equipment where extreem toughness is required. Tractors, rock crushers, and power shovels use these steels.

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SECTION NINE

PRINCIPLES OF MEASUREMENT AND INSPECTION

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates the ability to measure using precision instruments.

BENCHMARK: The trainee identifies the seven major parts of a micrometer caliper.

ASSESSMENT: Given a picture of a micrometer caliper the trainee points to and identifies the following parts:

1. Frame
2. Anvil
3. Spindle
4. Cam Lock Nut
5. Screw Nut
6. Thimble
7. Ratchet Sleeve

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates the ability to measure using precision instruments.

BENCHMARK: The trainee uses the micrometer caliper to take measurements.

ASSESSMENT: Given objects to measure, the trainee correctly uses the micrometer caliper and records accurate measurements.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates the ability to measure using precision instruments.

BENCHMARK: The trainee identifies various types of micrometers.

ASSESSMENT: Given a set of pictures of various types of micrometers the trainee identifies the following types:

1. Depth Micrometer
2. Blade Micrometer
3. Disc Micrometer
4. Screw Thread Micrometer

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates the ability to measure using precision instruments.

BENCHMARK: The trainee describes the proper care of the micrometer.

ASSESSMENT: The trainee provides the following information:

1. A micrometer is a precision measuring instrument. It must be handled with a great deal of care if its accuracy is to be maintained.

2. Oil the screw threads on the spindle to prevent wear and preserve the threads. Wipe the micrometer with an oily rag to keep it clean.

3. Keep the face of the anvil and spindle clean.

4. If the zero line on the thimble does not coincide with the zero line on the index line, loosen the cap on the end of the thimble. Reset the thimble to zero. Adjust to the correct position, and tighten the cap.

5. When taking a measurement, use a very light pressure to obtain a correct reading. Use only the fingertips to set the measurement.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee identifies and demonstrates an understanding of vernier tools.

BENCHMARK: The trainee identifies various vernier tools.

ASSESSMENT: Given a set of pictures showing vernier tools, the trainee identifies the following tools:

1. Vernier Caliper
2. Vernier Height Gage
3. Micro-Height Gage
4. Vernier Depth Gage
5. Universal Bevel Protractor
6. Sine Bar
7. Sine Plates

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee identifies and demonstrates an understanding of vernier tools.

BENCHMARK: The trainee identifies the parts of a vernier caliper.

ASSESSMENT: Given a picture of a vernier caliper, the trainee names the following parts:

1. Fixed Jaw
2. Movable Jaw with Vernier
3. Adjusting Screw
4. Bar
5. Clamping Screw

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee identifies and demonstrates an understanding of vernier tools.

BENCHMARK: The trainee identifies the primary function of selected vernier tools.

ASSESSMENT: The trainee provides the following minimum information:

1. Vernier Height Gage - Marks off vertical distances from a plane.
2. Sine Bar - Measures angles and locating work at a desired angle to some other surface or line.
3. Trainee identifies the function of other vernier tools as selected by instructor.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee identifies and describes the use of gages.

BENCHMARK: The trainee identifies various types of gages.

ASSESSMENT: Given a set of pictures or actual gages, the trainee identifies the following gages:

1. Snap Gage
2. Ring Gage
3. Plug Gage
4. Thread Ring Gage
5. Thread Snap Gage
6. Dial Snap and Bore Gages
7. Comparators

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee identifies and describes the use of gages.

BENCHMARK: The trainee describes the function of various gage types.

ASSESSMENT: The trainee provides the following information:

1. Protractor - Is used for setting bevels, transferring angles, and other classes of work.

2. Thickness Gages - Are sometimes called feeler gages. They are extensively used in the manufacture and servicing of autos.

3. Fillet and Raduis Gages - Is used to check concave and convex radii on corners or against shoulders.

4. Go and No-Go Gages - These gages are usually accepted as the most practical, accurate, and economical method of inspecting production tolerances. They check given dimensions by direct physical contact. They have two fixed parts, one to admit the dimension being checked and another to refuse the dimension.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the tools used to measure surfaces.

BENCHMARK: The trainee names three instruments used to check the accuracy of a surface or the condition of a finish. The trainee describes the use of each tool.

ASSESSMENT: The trainee provides the following information:

1. Surface Plate - This established the reference plane from which all precision measurement starts, is transferred, or is interpolated. Used with other fixed gages, the plate itself becomes a gage.

2. Surface Gage - A surface gage is used to transfer measurements and check the accuracy or parallelism of surfaces. It is also used in layout work for scribing lines on vertical or horizontal surfaces. It is also used in inspection work as a height gage or depth gage.

3. Optical Flat - Interferometry is the interpretation of the fringe patterns that result when rays of light interfere with each other. Measurements can be made to one-millionth of an inch by interferometry. For this type of measurement there is a choice of two classes of tools: (1) simple optical flats, or (2) complex interference instruments, usually called interferometers.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of layout tools and their function.

BENCHMARK: The trainee defines the term "layout" as it is used in Machine Shop.

ASSESSMENT: The trainee provides the following information:

The term "layout" means transferring lines, centers, and other informative markings form the blueprint directly onto the workpiece. This information serves as a guide for shaping the finished piece.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of layout tools and their function.

BENCHMARK: The trainee identifies layout tools.

ASSESSMENT: Given a set of pictures or actual tools, the trainee correctly names the following tools:

1. Surface Plates
2. Scriber
3. Prick Punch
4. Center Punch
5. Transfer Punch
6. V-Block
7. Toolmaker's Parallel Clamps

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates an understanding of layout tools and their function.

BENCHMARK: The trainee names the layout tools and describes their function.

ASSESSMENT: The trainee provides the following information:

1. Surface Plates - Layout work is normally done on a special table with a granite or cast iron top.
2. Scriber - A sharp, pointed tool used with a square rule or a straight edge to draw straight lines.
3. Prick Punch - A layout tool used to mark the location of holes after the lines have been scribed on the workpiece.
4. Center Punch - The center punch looks like a prick punch. However, the point of the center punch is ground to an angle of about 90°. It is used to enlarge prick punch marks so that a drill can be started accurately and easily.
5. Transfer Punch - Used in layout work to accurately transfer holes of any diameter from .125 to .500.
6. V-Blocks - Used to hold round stock for layout work in drilling, milling, grinding, and other machine operations.
7. Toolmaker's Parallel Clamps - Used to hold small work together during layout.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands principles of measurement and inspection used in Machine Shop.

INDICATOR: The trainee demonstrates knowledge of basic layout procedure.

BENCHMARK: The trainee identifies the basic steps to follow when laying out a workpiece.

ASSESSMENT: The trainee provides the following information:

1. Remove any burrs on the material. Use a file for this.
2. Coat the surface with layout dye.
3. Place the workpiece on a surface plate so that all dimensions can be made from the surface plate.
4. When several parallel lines are to be scribed, a temporary line can be made near the bottom of the workpiece. This will act as a check point.
5. In laying out the locations of holes, and all necessary lines, first scribe the center line along which they are to be drilled. A line then can be scribed with a square held at right angles to the workpiece. Prick punch at the intersection of these two lines.
6. Scribe a circle with a pair of dividers. Then enlarge the prick punch marks with a center punch.
7. Parallel lines and lines close to an edge or end may be made with a hermaphrodite caliper.
8. Angular lines may be laid out with a simple bevel protractor or a universal bevel protractor.
9. In using a steel rule, make sure the rule is kept parallel to the workpiece in order to obtain the correct length.
10. In squaring a line across the workpiece, hold the square firmly against the side of the work. Mark the line across the work with a scriber.

SECTION TEN

HAND TOOLS AND BENCHWORK

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the proper use of vises, hammers, and screwdrivers.

BENCHMARK: The trainee defines the terms "bench vise" and "machinist's vise".

ASSESSMENT: The trainee states:

The bench and the machinist's vise are used to hold workpieces for hand-tool operations such as filing, tapping, threading, and reaming.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the proper use of vises, hammers, and screwdrivers.

BENCHMARK: The trainee describes the machinist's hammer.

ASSESSMENT: The trainee states:

The machinist's hammer, or ball-peen hammer, has a flat face for general work and a round end for riviting and peening.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the proper use of vises, hammers, and screwdrivers.

BENCHMARK: The trainee describes the proper use of a screwdriver.

ASSESSMENT: The trainee states:

It is important to select the size of a screwdriver so that the thickness of the blade is a good fit in the screw slot. This prevents burring the slot. It also reduces the force required to hold the blade in place. Keep the blade squarely in line with the axis of the screw.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the proper use of vises, hammers, and screwdrivers.

BENCHMARK: The trainee uses vises, hammers, and screwdrivers correctly.

ASSESSMENT: Given a project which includes the use of vises, hammers, and screwdrivers, the trainee uses equipment appropriately. Instructor's evaluation indicates satisfactory completion of this benchmark.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function of a cold chisel.

BENCHMARK: The trainee describes the function of a cold chisel.

ASSESSMENT: The trainee states:

A metal working cold chisel is a forged tool used to shear, cut, and chip cold metal.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function of a cold chisel.

BENCHMARK: The trainee identifies, names, and describes the use of the four types of cold chisels.

ASSESSMENT: Given a set of pictures of chisels, the trainee identifies by name each type and explains its use as follows:

1. Flat - Is used for general chipping and cutting purposes, including the removal of rusted rivet and nut heads.

2. Diamond-Point - Is used for chipping V-shaped oil grooves and sharp corners.

3. Cape - Is forged to produce a cape or flare. Is used for cutting narrow slots or keyways and rectangular grooves.

4. Round-Nose - Is used for producing oil grooves and other concave surfaces.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies files and demonstrates the correct use of files.

BENCHMARK: The trainee explains what a file tool is and how it is used.

ASSESSMENT: The trainee states:

A file is a tool having cutting ridges or teeth on a surface or surfaces, used for smoothing or abrading metal and other materials.

COMPETENCY AREA:	PRODUCTION MACHINE SHOP
COMPETENCY STATEMENT:	The trainee is aware of common hand tools and benchwork typical to Machine Shop.
INDICATOR:	The trainee identifies files and demonstrates the correct use of files.
BENCHMARK:	The trainee identifies the three ways that files can be distinguished.
ASSESSMENT:	The trainee states (1) the length of the file, (2) the name of the file, or (3) the cut of the file.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies files and demonstrates the correct use of files.

BENCHMARK: The trainee identifies the four cuts of files.

ASSESSMENT: The trainee state (1) single cut, (2) double cut, (3) rasp cut, and (4) curved tooth.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies files and demonstrates the correct use of files.

BENCHMARK: The trainee identifies and names the various types of machinist's files.

ASSESSMENT: Given a set of pictures or actual files the trainee identifies, names, and describes the use of the following files:

1. Mill File - Used for drawfiling
2. Flat file - Used to remove large amount of stock.
3. Pillar file - Used for making slots and keyways.
4. Warding file - Used for filing ward ridges on locks and notches on keys.
5. Square file - Used for enlarging square holes and for filing slots and keyways.
6. Round file - Used on curved surfaces.
7. Three-square file - Used for internal filing and cleaning up square corners.
8. Half-round file - Used on concave surfaces.
9. Knife file - Used for the clean filing of sharp cut-in angles or inside corners.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies files and demonstrates the correct use of files.

BENCHMARK: The trainee names and describes the three basic ways to use a file.

ASSESSMENT: The trainee provides the following information:

1. Straight filing - This means pushing a file lengthwise, parallel with or slightly diagonally to the workpiece.
2. Draw filing - This is done to obtain a very smooth and level surface.
3. Lathe Filing - This means stroking the file against a workpiece that is revolving on a lathe.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies files and demonstrates the correct use of files.

BENCHMARK: The trainee outlines basic safety precautions and file care procedures.

ASSESSMENT: The trainee provides the following information:

1. Always use a file with a handle.
2. Do not strike the file with a hammer to drive on a handle.
3. A file card or brush should be used to keep the file clean. Brush in the direction of the teeth.
4. Files not in use should be hung on a rack to prevent them from rubbing together and blunting the teeth.
5. When filing, keep the teeth well chalked with chalk.
6. Never rap a file against a metal vise.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies files and demonstrates the correct use of files.

BENCHMARK: The trainee demonstrates the correct use of various files.

ASSESSMENT: Given a project requiring filing, the trainee selects the correct file, and uses it effectively.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee knows the meaning of the word broaching.

BENCHMARK: The trainee defines the term "broaching".

ASSESSMENT: The trainee states that broaching consists of forcing, by either pushing or pulling, a special tool across or through a piece of metal.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to correctly use a hand saw in the production of machine shop projects.

BENCHMARK: The trainee identifies a hacksaw and identifies the saw components.

ASSESSMENT: Given a set of tools, the trainee identifies the hacksaw and provides the following information:

1. Locates the "frame".
2. Locates the "blade" and notes the three things to consider when choosing a blade are the type of steel, type of blade (rigid or flexible), and pitch of the blade (number of teeth per inch).
3. Notes the set of the blade (the manner in which the teeth are bent).

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to correctly use a hand saw in the production of machine shop projects.

BENCHMARK: The trainee identifies common mistakes to avoid when using a hacksaw.

ASSESSMENT: The trainee provides the following information:

1. Don't start sawing on a corner or at a sharp angle to the work surface.

2. If you get off the guide line, don't try to straighten it out. Turn the piece over and start a new cut from the opposite side at a point that will remove the first groove when completed.

3. Don't force a new blade into a cut started with an old blade. The blade may break.

4. Don't force the saw with too much pressure or too rapid strokes.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to correctly use a hand saw in the production of machine shop projects.

BENCHMARK: The trainee uses a hacksaw correctly while working on assigned projects in Machine Shop.

ASSESSMENT: When working on a project requiring the use of a hackwaw, the trainee selects the correct blade and demonstrates the ability to use the saw appropriately.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of screw threads.

BENCHMARK: The trainee names the three basic applications for the use of screw threads.

ASSESSMENT: The trainee states:

1. To hold parts together.
2. To adjust parts with reference to each other.
3. To transmit power.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of screw threads.

BENCHMARK: The trainee identifies and names the parts of a screw thread.

ASSESSMENT: Given a picture of a screw thread, the trainee identifies the following parts:

1. Major diameter.
2. Minor diameter.
3. Pitch diameter.
4. Pitch.
5. Lead.
6. Crest.
7. Root.
8. Axis.
9. Depth of thread.
10. Thread angle.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of taps and dies.

BENCHMARK: The trainee describes a tap and identifies tap styles.

ASSESSMENT: The trainee provides the following information:

1. A tap is a tool used for cutting internal threads. The threads on a tap are not continuous. The cutting edges are formed by flutes that are cut lengthwise across the threads.

2. The trainee identifies different tap styles, including taper, plug and bottoming.

3. The trainee identifies an adjustable tap wrench, and a T-handle tap wrench.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of taps and dies.

BENCHMARK: The trainee identifies various types of taps.

ASSESSMENT: Given a set of pictures, the trainee names the following taps:

1. Serial Taps
2. Acme Taps
3. Gun Taps
4. Spiral-Fluted Taps
5. Pipe Taps

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of taps and dies.

BENCHMARK: The trainee taps a hole.

ASSESSMENT: Given a workpiece, the trainee drills a hole, then, correctly uses a tap to cut internal threads.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of taps and dies.

BENCHMARK: The trainee describes the use of thread cutting dies.

ASSESSMENT: The trainee states that threading dies are used to cut external threads. They are designed with internal threads having grooves or flutes. These grooves or flutes intersect the thread to provide space for the chips to escape.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the function and use of taps and dies.

BENCHMARK: The trainee identifies thread cutting dies.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies a round adjustable split die, a solid square die, a two-piece threading die, a stationary self-opening die head, and a tangential rotary die head.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the correct use of tapping and threading machines.

BENCHMARK: The trainee names the machines that can tap a hole.

ASSESSMENT: The trainee states:

1. Lathes
2. Drill presses
3. Turret lathes
4. Special tapping machines

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the correct use of tapping and threading machines.

BENCHMARK: The trainee names factors to consider in determining the best tapping speed.

ASSESSMENT: The trainee states:

1. Kind of material to be tapped.
2. Depth of hole.
3. Chamfer length on tap.
4. Pitch of thread.
5. Percentage of full thread to be cut.
6. Cutting fluids.
7. Type of equipment.
8. Vertical or horizontal tapping.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the correct use of tapping and threading machines.

BENCHMARK: The trainee demonstrates the correct use of a vertical tapping machine on designated projects.

ASSESSMENT: Given an assignment which requires the use of the vertical tapping machine, the trainee demonstrates the correct procedure, and produces a product which is acceptable. Instructor's evaluation indicates successful completion of assignment.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the correct use of tapping and threading machines.

BENCHMARK: The trainee describes the purpose of thread grinding.

ASSESSMENT: The trainee provides the following information:

Thread grinding is used for finishing coarse threads that have been previously machined and then heat-treated. It also is used for forming threads from solid, hardened material.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates an understanding of the correct use of tapping and threading machines.

BENCHMARK: The trainee names the two types of thread grinding wheels.

ASSESSMENT: The trainee states,

1. single wheel
2. plunge-cut wheel

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to use a reamer.

BENCHMARK: The trainee defines the term "reaming".

ASSESSMENT: The trainee provides the following information:

Reaming is an operation for finishing a hole very smoothly to the exact size. In precision work it is often impossible to drill a hole of the exact size or degree of smoothness required. In such cases the hole is drilled slightly undersize. It is then perfected (finished) with a reamer.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to use a reamer.

BENCHMARK: The trainee identifies and names the parts of a hand reamer.

ASSESSMENT: Given a picture of a hand reamer the trainee labels the following parts:

1. Relieved Land
2. Margin
3. Cutting Edge
4. Flutes
5. Land
6. Core Diameter
7. Cutting Face
8. Heel
9. Relied Angle
10. Shank
11. Cutter Sweep

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to use a reamer.

BENCHMARK: The trainee identifies and names various types of reamers.

ASSESSMENT: The trainee provides the following information:

1. Expansion hand reamer - used for enlarging a hole a few thousandths of an inch.
2. Finishing reamer - used to size and smooth the hole.
3. Chucking reamers - designed to provide efficient reaming in a wide range of materials.
4. Rose chucking reamers - used primarily as roughing reamers.
5. Shell reamers - High-speed machine reamers.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee demonstrates the ability to use a reamer.

BENCHMARK. The trainee demonstrates the use of a hand reamer.

ASSESSMENT: Given a workpiece, the trainee correctly demonstrates the use of a hand reamer. Instructor's evaluation indicates successful completion of assignment.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the correct use of assembling tools.

BENCHMARK: The trainee identifies and names various tools used for assembling.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies and names the following tools:

1. Slip-joint pliers - used for cutting wire and holding flat or round stock.
2. Side-cutting pliers - used in electrical work for cutting heavy or light wire or nails.
3. Long-nose pliers - used for cutting and holding fine wire.
4. Diagonal pliers - used for cutting medium or fine wire and bending small pieces of soft metal.
5. Open-end wrench - used to turn nuts and bolts.
6. Single open-end wrench (same)
7. Double open-end wrench (same)
8. Adjustable open-end wrench (same)
9. Double-offset box wrench (same)
10. Hook spanner wrench (same)
11. Pin spanner wrench (same)

COMPETENCY AREA:	PRODUCTION MACHINE SHOP
COMPETENCY STATEMENT:	The trainee is aware of common hand tools and benchwork typical to Machine Shop.
INDICATOR:	The trainee identifies and demonstrates the correct use of assembling tools.
BENCHMARK:	The trainee uses various types of assembling tools correctly.
ASSESSMENT:	Given a machine shop project, the trainee selects the correct assembly tool, and uses each tool correctly. Instructor's evaluation indicates successful completion of this benchmark.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the correct use of metal fasteners.

BENCHMARK: The trainee describes the fundamental use of metal fasteners and names common types of fasteners.

ASSESSMENT: The trainee provides the following information:

Metal fasteners are used to hold two or more pieces of metal in a given position, either temporarily or permanently. Common metal fasteners are bolts, nuts, screws, rivets, and pins.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates an understanding of the correct use of metal fasteners.

BENCHMARK: The trainee distinguishes between screws, bolts, nuts, washers, and rivets.

ASSESSMENT: The trainee provides the following information:

1. Screws: differ from bolts in the way they fasten two pieces together. Screws pass through a clearance hole in one piece and screw into a tapped hole in the other piece. They are made with square, hexagon, flat, or fillister heads.

2. Bolts: Flat countersunk head or round head, rolled threads. Threads start at a lower point than on a screw.

3. Nuts: most common nut are hexagonal and square. Grades as regular and heavy. Nuts have grooves in their upper face to receive a pin.

4. Washers: are placed under bolt heads and also between a nut and a workpiece. A lock washer is used to prevent a nut from working loose. A flat washer protects the finished surface of the work from being marred when the bolt or nut is tightened.

5. Rivets: are regarded as permanent fastenings.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates an understanding of the correct use of metal fasteners.

BENCHMARK: The trainee identifies and names various types of screws, bolts, and nuts.

ASSESSMENT: Given a set of pictures which show various types of screws, bolts, and nuts, the trainee labels the picture with the correct name of the fastener.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee is aware of common hand tools and benchwork typical to Machine Shop.

INDICATOR: The trainee identifies and demonstrates the correct use of metal fasteners.

BENCHMARK: The trainee selects and uses the correct fasteners in the completion of machine shop projects.

ASSESSMENT: Given a machine shop project, the trainee demonstrates his knowledge of fasteners by the correct selection and use of the various types of fasteners in the completion of a project.

SECTION ELEVEN

PLANNING PROJECTS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates an understanding as to how to plan for his/her Machine Shop work assignments.

BENCHMARK: The trainee completes a planning sheet.

ASSESSMENT: The trainee completes a project planning sheet by providing the lettered number of pieces, the rough size, the part name, and the kind of material that is intended to be used.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee understands typical Machine Shop practices.

INDICATOR: The trainee demonstrates an understanding as to how to plan for his/her Machine Shop work assignments.

BENCHMARK: The trainee develops a plan of procedure.

ASSESSMENT: The trainee provides the following information:

1. A list of all the tools and equipment that is needed to construct the project.

2. A break-down of the project into its smallest parts and a list of all the steps necessary to make each part.

3. After the parts have been made the trainee provides an analysis of how to assemble the piece.